



The effect of carbon reduction regulations on contractors' awareness and behaviors in China's building sector



Lianying Zhang*, Jinli Zhou

College of Management and Economics, Tianjin University, 92 Weijin Road, Nankai District, Tianjin 300072, China

ARTICLE INFO

Article history:

Received 5 May 2015

Received in revised form

2 December 2015

Accepted 3 December 2015

Available online 23 December 2015

Keywords:

Carbon reduction regulations

Awareness and behaviors

Contractors

China's building sector

ABSTRACT

Reducing carbon emissions in the building sector is of great significance to the development of Chinese society and economy. The Chinese government has issued various regulations to promote carbon reduction behaviors for contractors. However, the effect of these regulations is still unknown or confusing. To bridge this gap, this research investigated the relationships among government carbon reduction regulations, contractors' carbon reduction awareness and carbon reduction behaviors. Then a conceptual model was developed, and Structural Equation Modeling was applied to validate the model. The findings reveal that carbon reduction regulations positively correlate with carbon reduction awareness and behaviors, and carbon reduction awareness partially mediates the relationship between carbon reduction regulations and behaviors. The results show that adopting carbon reduction regulations is an effective way, and improving carbon reduction awareness is a possible way to encourage contractors' carbon reduction behaviors. Some incentives can also be taken for contractors to reduce the gap between carbon reduction awareness and behaviors. The findings are valuable for policy makers to improve the development of low carbon construction in China, and for contractors to make appropriate responses to carbon reduction regulations.

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1. Introduction

In response to growing concern about climate change, reducing carbon emissions has become a consensus around the world (Alhorr et al., 2014). Many countries have set long term goals for carbon reduction (IPCC, 2007). For example, the Australian government has committed to reduce the national carbon emissions to a maximum of 25% below the 2000 level by 2020 (Wong and Zapantis, 2013), and the UK government has set itself a 60% reduction of carbon emissions on 2000 levels by 2050 (Osmani and O'Reilly, 2009). As the largest carbon emitter in the world, the Chinese government has set a target of reducing 17% carbon intensity over the 12th Five-Year Plan period (2011–2015) (State Council, 2011). Since the building sector accounts for 25–27% of the country's greenhouse gas emissions in China (Li, 2007), achieving carbon reduction in this sector can have significant meaning to the development of Chinese society and economy.

Whilst firms' awareness of carbon reduction is improving, there is still an important gap between awareness and behaviors (Liu, 2012). In the construction industry, sustainability is still a relatively new concept, which has not attracted considerable attention in the developing world (Christini et al., 2004). A widespread agreement on sustainable construction does not mean a widespread implement action (Ashley et al., 2003). Hence, Sakr et al. (2010) studied the awareness of environmental management systems of the top 50 contractors in Egypt. Abidin (2010) investigated the awareness, knowledge and implementation of sustainable practices on the perceptions of the project developers in Malaysia. In addition, some researchers studied the barriers to energy efficiency and carbon reduction activities in the construction industry, e.g. Zuo et al. (2012), Baek and Park (2012), and Kostka et al. (2013). According to their results, lack of government regulations is regarded as one of the most important barriers. Liu (2009) also showed that pressure from the government regulation is the main factor influencing a firm's environmental behaviors. To improve contractors' awareness and behaviors about reducing carbon emissions, the Chinese government has issued a series of regulations about energy efficiency and renewable energy application in buildings (Yuan et al., 2013). Li (2008) investigated the potentials of

* Corresponding author.

E-mail addresses: tjzly126@126.com, zhanglianying@tju.edu.cn (L. Zhang), zhoujinli9@126.com (J. Zhou).

energy saving and greenhouse gas emission mitigation offered by implementing building energy efficiency policies in China. [Lu et al. \(2012\)](#) discussed the effectiveness and equity of carbon policies in the construction industry of United States. [De Melo et al. \(2013\)](#) evaluated the effects of public policy mechanisms for climate change mitigation in Brazilian buildings sector. Other studies further showed the effects of environmental regulations on firms' various behaviors, such as plant location decisions ([Jeppesen et al., 2002](#)), environmental management ([Jones, 2010](#)), building design and procurement ([Hamza and Greenwood, 2009](#)). However, there is still a lack of empirical research on the effect of government regulations on firms' carbon reduction awareness and behaviors, especially in the building sector. Due to construction contractors' important role in reducing carbon emissions under their control ([Wong et al., 2013](#)), the present study aims to explore this issue from the perspective of construction contractors.

2. Conceptual model development

To evaluate the effect of carbon reduction regulations on contractors' carbon reduction awareness and behaviors, a conceptual model was developed. The model is underpinned by three streams of studies, namely carbon reduction regulations, carbon reduction awareness and carbon reduction behaviors.

2.1. Carbon reduction regulations

According to [Sinclair-Desgagné \(1999\)](#), environmental regulation is an industrial policy instrument aimed at increasing the competitiveness of firms, as well-designed environmental regulation could drive firms' innovations. After recognizing the pluralism and strength of regulation, [Levi-Faur \(2011\)](#) suggested regulation is the promulgation of prescriptive rules as well as the monitoring and enforcement of these rules by social, business, and political actors on other social, business, and political actors. Different researchers have categorized environmental regulations into different types. [Wong and Zapantis \(2013\)](#) grouped the policy drivers of carbon reduction into carbon tax, emission trading schemes, penalty and tightening regulations. [López-Gamero et al. \(2010\)](#) pointed out two broad types of environmental regulations, namely command-and-control regulations and incentive-based regulations. According to the ratio and degree of compulsion, [Testa et al. \(2011\)](#) specified the form of environmental regulation into direct regulation, economic instruments and soft instruments. This study also classifies Chinese carbon reduction regulations into the three types of direct carbon regulations (DCR), economic carbon instruments (ECI) and soft carbon instruments (SCI). DCR are standards about clear commands or prohibitions that a company should or should not do to save energy and reduce carbon emissions. They are compulsory for all contractors in China. ECI include all economic measures that encourage contractors to reduce carbon emissions, such as subsidies, tax deduction and tax exemption. SCI are voluntary for contractors to comply with, such as green procurement practices and green building certification schemes. The voluntary measures present many opportunities for contractors to increase their relative competitiveness in the market. The effectiveness of government regulations on contractors can be measured by their attitudes of demand, impact and appropriateness toward the regulations ([Qi et al., 2010](#)).

Overall, the ideal goal of carbon reduction regulations is to instruct organizations or individuals to reduce carbon emissions. Organizations' reaction to carbon reduction regulations usually starts from awareness, and ends in behavior. For contractors, regulations have been the main driving force to adopt green innovation strategies and practices ([Fergusson and Langford, 2006](#)). Strengthening government regulations on carbon reduction can

enhance contractors' carbon reduction awareness and behaviors. Accordingly, the following hypotheses are proposed:

H1. Government carbon reduction regulations have a positive impact on contractors' carbon reduction behaviors.

H2. Government carbon reduction regulations have a positive impact on contractors' carbon reduction awareness.

2.2. Carbon reduction awareness

Environmental awareness has been described as a multi-dimensional construct. According to [Grob \(1995\)](#), environmental awareness is represented by environmental knowledge and the recognition of environmental problems. [Abdul-Wahab \(2010\)](#) assessed the level of environmental awareness by environmental knowledge, attitude and behavior. [Zsóka \(2008\)](#) analyzed the components of corporate environmental awareness by environmental knowledge, values, attitudes, willingness to act and actual behavior. [Liu and Bai \(2014\)](#) specified the awareness domain for developing the circular economy into knowledge, values and willingness to act. Since this research separates out behaviors from awareness, and environmental knowledge, values and attitudes are the most frequently mentioned components of awareness in the relevant literature, the domain of contractors' carbon reduction awareness is identified by their organizational knowledge (OK) of, organizational values (OV) of and organizational attitudes (OA) toward carbon reduction.

Environmental knowledge can be defined as knowledge of the facts, concepts and relationships concerning the natural environment ([Fryxell and Lo, 2003](#)). For contractors, knowledge about carbon reduction is usually presented in the form of organizational documents. Then in this research, contractors' carbon reduction knowledge is evaluated by their knowledge of facts, concepts and negative effects of construction carbon emissions in their organizational documents. Values are difficult to measure because they cannot be observed directly and people are often not clear about their values. In case of companies, organizational culture can give us insights into the assessment of organizations' environmental values ([Zsóka, 2008](#)). Reducing carbon emissions is an advanced reflection of environmental protection, and both of them are parts of corporate social responsibility. Then contractors' carbon reduction values can be evaluated by the recognition of corporate social responsibility, environmental protection responsibility and carbon reduction responsibility in their organizational culture. Attitude is a positive or negative feeling toward specific objects, and it is an enduring orientation with cognitive, affective, and behavioral components ([Sears et al., 1985](#)). If a contractor has positive attitudes toward carbon reduction, it can be reflected by the contractor's change in organizational strategies. Organizational change strategies contain five infrastructure strategies of goals, human resource, technology, structure and culture ([Sadeghi, 2011](#)). As for carbon reduction strategies, contractors' changes can mainly be seen in organizational goals, structure and human resource. Contractors' carbon reduction attitudes are then evaluated by their changes in organizational goals, organizational structure and human resource about carbon reduction.

Although there is an important gap between environmental awareness and behavior, environmental awareness is the first major step in preparing people to solve environmental problems ([Ramsey et al., 1992](#)). Thus there is no doubt contractors' carbon reduction awareness is the premise of their carbon reduction behaviors, and hypothesis 3 is proposed. In addition, contractors' carbon reduction awareness may be strengthened by government carbon reduction regulations, and then their carbon reduction behaviors are conducted. As a result, hypothesis 4 can be proposed. The two hypotheses are as follows:

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